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(71) Applicant: DELPHI TECHNOLOGIES, INC. [US/US]; Legal Staff - Mail Code: 480-414-420, P.O. Box 5052, Troy, MI 48007 (US).

(72) Inventors: GREENWALD, Pamela, Sue; 12150 Volpe Drive, Sterling Heights, MI 48312 (US). WOODMAN, Daniel, S.; 3713 Hogback Road. Fowlerville, MI 48836 (US). BECKLEY, Daniel, V.; 2320 Tomahawk, Lapeer, MI 48446 (US).

(74) Agent: MARRA, Kathryn, A.; Delphi Technologies, Inc., Legal Staff, M/C 480-414-420, P.O. Box 5052, Troy, MI 48007-5052 (US).

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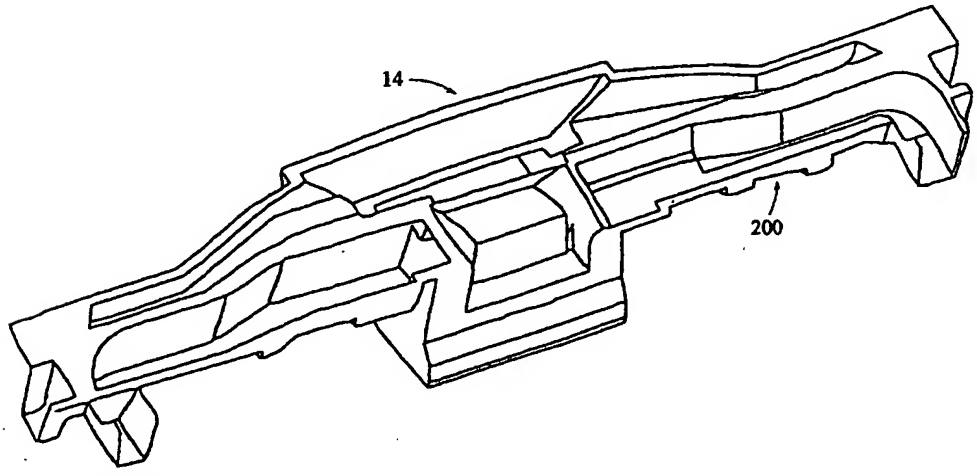

(57) Abstract: The invention offers advantages and alternatives over the prior art by providing a structural panel (10), e.g., an instrument/cockpit panel, having a plurality of knee energy absorbers (90, 140) integrally formed therewith. According to the present invention, each knee energy absorber (90, 140) extends outwardly from the structural beam (16) and is designed to manage energy during preselected events. More specifically, each knee energy absorber (90, 140) is formed of at least two surfaces (81, 83, 143, 145) which extend away from a rear surface of the structural beam and converge with one another at a section (85, 147). This section (85, 147) represents the most rearward portion of the structural beam (16) in that the section (85, 147) is closer to occupants of the vehicle. In another aspect of the present invention, each knee energy absorber (514) may include an integral attachment feature (526) extending therefrom for providing attachment locations for various trim components and for an instruments panel cover.

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STRUCTURAL BEAM WITH INTEGRATED KNEE ENERGY ABSORBERS

TECHNICAL FIELD

This invention relates generally to automotive interior structures and more particularly to a structural beam having integral knee energy absorbers.

BACKGROUND OF THE INVENTION

It is well known in motor vehicles to provide a structural beam, e.g., an instrument panel beam, extending transversely between the front pillars of an automotive body to provide structural rigidity to the vehicle and to mount interior components using mounting brackets, fasteners and other joining techniques. Likewise in a cockpit setting, a structural beam extends thereacross. Motor vehicles include a plurality of interior components mounted in the forward portion including steering column supports, driver and passenger knee bolsters, vehicle instruments, air bags, etc. The typical motor vehicle instrument panel structure is comprised of a metal beam assembly fastened to and extending between the front pillars of the vehicle. During manufacturing of a vehicle instrument panel structure, the beam is located in a fixture and locating tools are used to accurately and properly position component brackets to be attached to the beam. The components, typically extending from these brackets, are located relative to the beam and are typically attached to the beam assembly using a plurality of fasteners. Existing designs also include tubular beams and stamped beams requiring brackets and multiple fasteners to securely fasten components in place along the beam. The location and attachment of component brackets in existing instrument panel structure designs is time consuming, expensive and fairly difficult to adapt to changing designs and alternate vehicle configurations. Such designs, because of the

plurality of parts, fasteners and bracket, are also prone to problems caused by vibration, squeaks, rattles and dimensional stability.

It is also known in the art to manufacture instrument panel beams from plastic and fiber reinforced plastic materials. Some of these designs include pockets adapted to receive various components which are secondarily bonded or fastened therein. The pockets provided in this type design allow for easier location and placement of components however, as is a problem with the metal beams discussed above, this type of design is also inflexible. Molds for manufacturing plastic beams are difficult and expensive to change as well as the requirement that each type of beam requires a separate mold.

One component that is commonly attached to the instrument panel beam is a plurality of knee energy absorbers. Typically, the knee energy absorbers comprise stand alone knee absorbers which are multi-piece weldments which are mechanically fastened to the instrument panel beam in a secondary operation. Thus, knee energy absorbers are conventionally separate members from the instrument panel beam which are attached thereto in subsequent processing steps which increases the cost and time necessary for assembling the instrument panel.

SUMMARY OF THE INVENTION

This invention offers advantages and alternatives over the prior art by providing a structural beam having integral knee energy absorbers. According to the present invention, the structural beam includes integrally molded knee energy absorbers which extend outwardly therefrom and are designed to absorb energy during preselected events. More specifically, each knee energy absorber is formed of at least two surfaces which extend away from a rear surface of the structural beam and converge with one another at a section. This section represents the most rearward portion of the structural beam in that the section is closer to occupants of the vehicle. The knee energy absorbers are formed during the same molding process which forms the entire structural beam

and therefore a solid connection results between the knee energy absorbers and the structural beam because the knee energy absorbers are integral with the structural beam itself.

In another aspect of the present invention, each knee energy absorber may include an integral attachment feature (tab) extending therefrom for providing attachment locations for various trim components and for an instrument panel cover. In one exemplary embodiment, the integral trim attachment is formed at a lowermost portion of the knee energy absorbing bracket and the attachment extends downwardly therefrom. Preferably, the trim attachment includes an opening which is designed to permit the various trim attachment and/or the instrument panel cover to be easily attached to the structural beam.

The present invention also provides the ability to tune occupant energy performance by strategic material selection and part design. For example, a characteristic energy performance may be provided by selecting a material which will provide the desired energy characteristics and/or configuring the design of the knee energy absorber so that the desired energy performance is provided using the selected material. By integrating the knee energy absorbers with the structural beam, the present invention provides a more robust system design because it includes fewer attached parts. By eliminating or using fewer attached parts, there is reduced opportunity for squeaks and rattles and other quality deficiencies to occur. Other advantages of the present invention are discussed herein and include improved recyclability, a reduction in production costs, and ease of manufacture.

The above discussed and other features and advantages of the present invention will be appreciated and understood by those skilled in the art from the following detailed description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described, by way of example only, with reference to the accompanying drawings wherein like elements are numbered alike in the several Figures:

Figure 1 is an exploded view of an exemplary integrated structural beam assembly;

Figure 2 is a perspective view of a first section of the integrated structural beam assembly of Figure 1;

Figure 3 is a perspective view of a second section of the integrated structural beam assembly of Figure 1;

Figure 4 is a top plan view of an exemplary first section for use with the integrated structural beam assembly of Figure 1;

Figure 5 is a bottom plan view of the second section of the integrated structural beam assembly of Figure 1;

Figure 6 is a top perspective view of the second section of the integrated structural beam assembly of Figure 1;

Figure 7 is a partial cross-sectional bottom plan view of the second section of the integrated structural beam assembly of Figure 6 taken along the line 7-7;

Figure 8 is a cross-sectional side elevational view of the integrated structural beam assembly of Figure 1;

Figure 9 is a perspective view of a first section according to a second embodiment;

Figure 10 is an enlarged view of a portion of the first section of Figure 9 showing an exemplary knee energy absorber; and

Figure 11 is a perspective view of a first section according to a third embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1 there is shown one exemplary integral structural beam, e.g., cockpit/instrument panel structure, generally designated at 10. More specifically, the integral cockpit/instrument panel structure comprises an integrated structural HVAC system (ISHS) 10 including a plurality of molded features. The ISHS 10 comprises a first section 12 and a second section 14. In the illustrated embodiment, the first section 12 comprises an upper section. The first section 12 includes a first cross beam 16 comprising a molded structure with integral features. The first cross beam 16 has an upper wall 18 having a first end 20 and an opposing second end 22. Intermediate the first and second ends 20, 22, the upper wall 18 has an outwardly bowed portion 24 where the width of the upper wall 18 is greater than a width at the first and second ends 20, 22. Proximate each of the first and second ends 20, 22, the upper wall 18 includes a first opening 26 formed therein. The first openings 26 provide a connection point for an attachment member (not shown) to be coupled to the first openings 26. In one exemplary embodiment, the first openings 26 provide integral shooter duct attachment locations. First openings 26 thus permit the attachment of a shooter duct assembly (not shown) or the like to the upper cross beam 16. As is known, the shooter duct assembly serves to direct air along a defined passageway to a desired remote location, e.g., a vent on an instrument panel (not shown).

Referring now to Figures 2-8. As shown in Figure 2, the upper wall 18 includes an elongated opening 30 formed therein and more specifically the elongated opening 30 is formed in the outwardly bowed portion 24 thereof. The elongated opening 30 is also formed intermediate the first openings 26. In the exemplary embodiment, the elongated opening 30 serves as a defroster opening to direct air therethrough to make contact with a windshield (not shown) for defrosting thereof when the user has activated and selected for an air supply device (not shown) to provide air to the windshield for such defrosting action. The upper wall 18 further includes a plurality of structural ribs 32

formed therein. In the illustrated embodiment, the plurality of structural ribs 32 is formed between the first openings 26 and between the elongated opening 30 and an integral wire channel 40 which is formed on the upper wall 18 and extends longitudinally across the upper wall 18. The integral wire channel 40 comprises a member having a center tract 42 for receiving wiring harnesses and the like. By disposing wires and the like within the center tract 42, the wires are located and protected from other components while at the same time, the wires may be conveniently routed across the ISHS 10. The plurality of structural ribs 32 may take a variety of shapes and in the illustrated embodiment, each structural rib 32 is rectangular in shape. The structural ribs 32 may be orientated in a number of patterns which are formed of a predetermined number of rows and columns in order to provide the desired structural rigidity to the upper cross beam 16. For example in the exemplary embodiment shown, the structural tabs 32 are orientated in a pattern having three (3) rows and a predetermined number of columns.

The first section 12 further includes a rear wall 52 which is integrally connected to the upper wall 18. It being understood that the rear wall 52 generally faces occupants in a vehicle compartment (not shown) when the ISHS 10 is mounted between a vehicle body. The rear wall 52 has a first end 53 and an opposing second end 55, wherein the first end 20 of the upper wall 18 is orientated next to the first end 53 of the rear wall 52. In the exemplary and illustrated embodiment, the upper wall 18 and the rear wall 52 are generally perpendicular to one another. The rear wall 52 extends from the first end 20 to the second end 22 of the upper wall 18. Rear wall 52 has a number of integral extruded features including recessed grooves, openings, and raised portions extending therefrom, as will be described in greater detail hereinafter.

More specifically, the rear wall 52 includes a pair of end openings 60 formed proximate the first and second ends 53, 55. In an exemplary embodiment, the openings 60 are rectangular in shape. End openings 60 preferably serve as end vent outputs in which air is directed therethrough so

that the air may be routed to specific locations in the vehicle compartment for specific functions. The rear wall 52 further includes a pair of end arms 80 which are integrally formed with the rear wall 52 at the first and second ends 53, 55. The pair of end arms 80 extend downwardly away from the upper wall 18.

According to the present invention, the first section 12 includes a plurality of knee energy absorbers which are integrally formed as part of the first section 12. In an exemplary embodiment, the pair of end arms 80 of the first section 12 form a part of a pair of integral first knee energy absorbers 90. As is known in the art, the first knee energy absorbers 90 are used to hold a knee bolster (not shown) and also manage energy during predetermined events. Each first energy absorber 90 is generally "D" shaped in the illustrated embodiment and is formed of end arm 80, a first surface 81, and a second surface 83, wherein the first and second surfaces 81, 83 are integral with each other and converge at a section 85. The first surface 81 extends from a point on the end arm 80 to the section 85 where the first and second surfaces 81, 83 integrally converge. The second surface 83 extends from a second point (a lower end) of the end arm 80 to the section 85. Section 85 is the rearwardmost (closer to occupants of the vehicle) section of the ISHS 10.

The first surface 81 slightly slopes downward from the rear surface 52 and the second surface 83 slopes upwardly from the rear arm 80 to the section 85. The slope of the second surface 83 is greater than the slope of the first surface 81. An opening 87 is formed between and is defined by the rear arm 80, the first surface 81 and the second surface 83. Advantageously, the first knee energy absorber 90 is integral with the first section 12 and is thus formed during a single molding process in which the first section 12 and the molded features thereof are formed. By integrating the knee energy absorbers 90 into the first section 12 and more specifically as part of the first cross beam 16, the present invention provides for a readily recyclable sub-system. In other words, no disassembly is required nor separation of the materials is required during a recycling process. In addition, the integration of the knee energy absorbers 90

with the first cross beam 16 provides a reduction in cost due to a reduction in assembly time and a reduction in parts which leads to a cost savings. The integrated nature also provides an improvement in comparison with prior art assemblies (separate steel brackets fastened to the beam) again due to the present invention providing a single mass which is structurally solid because of the integrated nature thereof. The tooling cost is also improved in comparison with conventional devices because the present invention does not require separate tooling and operations to fabricate and assemble the first knee energy absorbing brackets 90 to the structural beam (first cross beam 16). Furthermore, the integration of the first knee energy absorbers 90 with the first cross beam 16 also improves the ease of manufacturing due to elimination of separate sub-assembly operations. Additional advantages of the present invention are noted hereinafter. The rear wall 52 also includes a central opening 100 formed therein intermediate to the pair of end openings 60. The central opening 100 is preferably positioned in the rear wall 52 so that central opening 100 is intermediate in relation to ends of the elongated opening 30 formed in the upper wall 18. The rear wall 52 also includes a raised portion 120 which includes a pair of upwardly extending raised arms 122 disposed adjacent to ends 124 of the central opening 100. The central opening 100 is also defined by a lower edge 126 which also comprises an edge of the raised portion 120. The raised portion 120 extends below a lower edge 130 of the rear wall 52 and has an arcuate surface 134 which extends longitudinally.

The rear wall 52 also includes a pair of second knee energy absorbers 140 which are integrally formed with the rear wall 52 and more specifically form a part of the raised portion 120. The second knee energy absorbers 140 are disposed intermediate to the first knee energy absorbing brackets 90. Each second knee energy absorber 140 is integrally formed as part of the first section 12 and more specifically, each second knee energy absorbing bracket 140 is integral with the raised portion 120 of the rear wall 52. Similar to the first knee energy absorbing bracket 90, each second knee energy absorber

140 is generally "D" shaped and includes a rear surface 141 which is integral with the raised portion 120 and first and second surfaces 143, 145. The first surface 143 extends outwardly from one point of the rear surface 141 and the second surface 145 extends outwardly from another point of the rear surface 141 and the first and second surfaces 143, 145 converge at a section 147. Section 147 is the rearward most point of the ISHS 10. An opening 149 is formed between the rear surface 141 and the first and second surfaces 143, 145, respectively.

The rear wall 52 also includes a predetermined number of depressions, generally indicated at 160, formed therein at specific locations. The depressions 160 may take a number of shapes and in the illustrated embodiment, the depressions 160 have a generally rectangular shape. Because in an exemplary embodiment, the first and second sections 12, 14, respectively, are coupled to one another by a welding process, e.g., vibration welding, the depressions 160 are used in the welding process to ensure that a secure fit and strong weld results between the first and second sections 12, 14. In the illustrated embodiment, three depressions 160 are formed between the center opening 100 and one of end openings 60. The rear wall 52 also has a predetermined number of extruded features in the form of integral air bag module attachments, generally indicated at 170. Each of the air bag module attachments 170 extends outwardly away from the rear wall 52 and are designed to mount an air bag module (not shown). According to the present invention, the first section 12 and the features thereof are integrally formed during a suitable molding process.

Similar to the first section 12, the second section 14 comprises an integral member including a second cross beam 200. The second cross beam 200 has a first end 202 and an opposing second end 204. The second cross beam 200 generally includes an upper surface 206 and a rear surface 208. The rear surface 208 includes an upper edge 210 and a lower edge 212. Integrally formed within the second cross beam 200 is an integral first fluid duct, generally

indicated at 220, which extends longitudinally across the second cross beam 200 from the first end 202 to the second end 204. The first fluid duct 220 comprises an integral channel formed within the second cross beam 200. The first fluid duct 220 is partially defined by the rear surface 208 and is also defined by an inner wall 222 which is spaced from the rear surface 208 to form the first air duct 220. The first fluid duct 220 has a first arcuate end portion 224 at one end and a second arcuate end portion 226 at an opposite end. More specifically, the first and second arcuate end portions 224, 226 comprise sections of the first fluid duct 220 which are generally perpendicular to the rear surface 208. Each of the first and second arcuate end portions 224, 226 are defined by a pair of spaced end wall extensions generally indicated at 239. Accordingly, the spaced end wall extensions 239 extend beyond the rear surface 208. As best shown in Figure 3, the first fluid duct 220 is open at a top portion thereof and is designed to permit air flow within the channel defined thereby and because the first and second arcuate end portions 224, 226 comprise bent portions, the fluid flowing within the channel is directed outwardly relative to the rear surface 208.

Referring specifically to Figures 1, 3, 5-7, the first fluid duct 220 has a center portion 240 which includes first and second connecting walls 242, 244 which extend latitudinally across the rear surface 208 to the inner wall 222. The connecting walls 242, 244 thus enclose the first fluid duct 220 on a third side so that the first fluid duct 220 has opposing center entrances in the form of generally rectangular openings, generally indicated at 250.

Intermediate the connecting walls 242, 244, the rear surface 208 has a cut-away portion 260 which is generally centrally formed between the first and second ends 202, 204. The cut-away portion 260 is defined by opposing parallel walls 262 defined in the rear surface 208 and a lower edge 264 which extends between the parallel walls 262 at a lower portion thereof. The second cross beam 200 also includes an integral HVAC module upper casework, generally indicated at 270. The HVAC module upper casework 270 has a rear surface 272 which is raised relative to the rear surface 208, wherein the raised

rear surface 272 includes a pair of integral raised opposing arms 273 which are formed on both sides of the cut-away portion 260. In other words, the opposing parallel walls 262 and the lower edge 264 comprise portions of the raised rear surface 272.

In one embodiment, the HVAC module upper casework 270 includes an arcuate surface 280 which is angled away from the rear surface 272. The arcuate surface 280 preferably has a complementary shape as the arcuate surface 134 so that during assembly of the ISHS 10, the arcuate surface 280 seats against the arcuate surface 134 in a complementary manner. The HVAC module upper casework 270 will be described in greater detail hereinafter.

The second cross beam 200 also includes a center fluid duct 290 integrally formed between the connecting walls 242, 244, wherein the center fluid duct 290 has a generally rectangular shape defined by a pair of side walls 292 and an upper wall 294 which extends between upper portions of the pair of side walls 292. The center fluid duct 290 has a duct opening 297 which is designed to permit fluid, e.g., to flow therethrough and exit the ISHS 10. The center fluid duct 290 is aligned with the cut-away portion 260 of the rear surface 208 so that the pair of side walls 292 are intermediate the opposing parallel side walls 262. Accordingly, the center fluid duct 290 is designed to permit air flow from the integral HVAC module upper casework 270 through the center fluid duct 290 to desired output locations along the instrument panel or the like.

According to the exemplary embodiment, the center fluid duct 290 is formed so that the center fluid duct 290 does not prevent fluid communication within the first fluid duct 220 wherein the air is permitted to flow through the HVAC module upper casework 270 and the slots 250 resulting in fluid communication within the first fluid duct 220 from the first arcuate end portion 224 to the second arcuate end portion 226. The center duct 290 thus generally partitions the first fluid duct 220 into a first section 221 and a second section 223.

Referring now specifically to Figures 6-7. As best shown in Figure 7, the HVAC module upper casework 270 is open ended and is defined by the rear surface 272, an opposing front surface 273, and opposing side surfaces 275. The surfaces 272, 273, 275 form a generally rectangular shaped member which has a cavity 291 defined thereby. The front surface 273 includes an inlet portion 277 which permit a fluid, e.g., air, to be directed into the HVAC module upper casework 270 for distribution therein. The inside portions of the surfaces 273, 275, 277 are contoured so that air flows along the surfaces thereof and is directed into the particular air duct for distribution of the air within the vehicle compartment.

As best shown in Figure 7, a center fluid director 291 is formed in the surface of the upper wall 294 of the center duct 290 for directing air which contacts the center fluid director 291. The center fluid director 291 is formed so that the fluid flows along the surfaces thereof and exits through the duct opening 297. Extending between the side walls 292 and the parallel walls 262 is a pair of first fluid directors 299 each of which is formed to direct the air entering the HVAC module upper casework 270 to the first fluid duct 220 and more specifically, the first fluid directors 299 direct the air to the slots 250 which comprise entrances into the first air duct 220 where the air is channeled to a desired location(s). It being understood that the occupant of the vehicle controls the air flow direction by selecting the appropriate mode using a controller or the like.

The rear portion of the center fluid duct 290 is preferably integral with the inner wall 222 and the center fluid duct 290 is in fluid communication with the HVAC module upper casework 270 so that air that is passed through the HVAC module upper casework 270 contacts the walls of the center fluid duct 290 and the air flow is directed thereby to a desired location.

Referring to Figures 2-8, the second cross beam 200 also includes a second fluid duct 300 formed therein. In an exemplary embodiment, the second fluid duct 300 is partially defined by the inner wall 222 and a front

wall 302 of the second cross beam 200. The second cross beam 200 also has a bowed-out portion 311 which comprises the widest section of the integral lower cross beam 200. As shown in the Figures, the front surface 302 is generally parallel to the rear surface 208 at ends thereof and intermediate thereto, the front surface 302 angles outwardly to form the bowed-out portion 311 of the second cross beam 200. The second fluid duct 300 preferably has a depth less than a depth of the first fluid duct 220 and in an exemplary embodiment, the second fluid duct 300 comprises an integral side window defogging air duct. The second fluid duct 300 is closed ended at ends 301 thereof and generally is formed of a first section 303 and a second section 305, where the first and second sections 303, 305 are formed on opposing sides of the HVAC module upper casework 270. The second fluid duct 300 is formed in the second cross beam 200 extending towards the first and second ends 202, 204 thereof and terminates in the closed ends 301 prior to intersecting the first and second ends 303, 305.

The second cross beam 200 also includes an integral third fluid duct 310 formed therein and disposed generally within the bowed-out portion 311 of the second cross beam 200. As best shown in Figures 5 through 7, the third fluid duct 310 comprises, in an exemplary embodiment, a rectangular opening. The design of the bowed-out portion 311 of the second cross beam 200 increases the area of the third fluid duct 310 and because the bowed-out portion 311 of the second cross beam 200 complements the bowed-out portion 24 of the first cross beam 16, the elongated opening 30 is positioned above the third fluid duct 310 so that fluid communication is provided between the elongated opening 30 and the third fluid duct 310. In the exemplary embodiment, the air flow from the third fluid duct 310 is channeled and used for a defrosting action in which the air flows through the elongated opening 30 and contacts the windshield for defrosting thereof. The third fluid duct 310 is also in fluid communication with the second fluid duct 300 so that air flowing into the HVAC module upper casework 270 through the inlet portion 277 flows

through the third fluid duct 310 and is permitted to fluidly flow within the second fluid duct 300. As best shown in Figure 4, openings 33 formed in the first section 12 are disposed above the second fluid duct 300 when the first and second sections 12, 14 are assembled so that fluid flowing within the second fluid duct 300 flows out through the openings 26 and is directed to a desired location within the vehicle compartment to accomplish a chosen function. e.g., defogging of side windows of the vehicle. In addition, other openings 35 may be formed in the first section 12 to provide mounting locations or to provide additional locations for the addition of other fluid ducts.

The second cross beam 300 also includes side mounting members 320 integrally formed therein. The side mounting members 320 are formed at each of the first and second ends 202, 204, respectively. As shown, the side mounting members 320 have opposing side walls 322 which are parallel to one another and define a slot 340 therebetween. Each of the side mounting members 320 is formed proximate one of the first and second arcuate end portions 224, 226. The slot 340 opens outwardly in a direction away from the first fluid duct 220. The side mounting members 320 are preferably used as mounting members for mounting the assembled ISHS 10 to the vehicle body. Figure 4 is a top plan view of an exemplary upper section 12 which is essentially the same member as that shown in Figure 1 with the exception that the plurality of structural ribs 32 is eliminated for purpose of illustration. In addition, openings 33 and 35 are illustrated and as previously mentioned, the first section 12 may have a number of openings formed therein at predetermined desired locations so that air may be directed to other conduits or members to provide certain functions, such as cooling or heating a location of the vehicle. Figure 5 is a bottom plan view of the second section 14 of the ISHS 10 and Figure 6 is a top perspective view of the second section 14. Figure 7 is a partial cross-sectional bottom plan view of the second section 14 and shows the HVAC module upper casework 270 in greater detail.

Referring now to Figures 1-8, the assembly of the ISHS 10 will now be described in greater detail hereinafter. To assembly the ISHS 10, the first section 12 is positioned generally above the second section 14. In orientating the first and second sections 12, 14 relative to one another so that the rear wall 52 of the first cross beam 16 and the rear surface 208 of the second cross beam 200 face the same direction and the rear wall 52 is disposed above the rear surface 208 of the second cross beam 200.

The first and second arcuate end portions 224, 226 are aligned with and inserted through the end openings 60 formed in the rear wall 52 of the first cross beam 16. Likewise during the assembly of ISHS 10, the center duct 290 is aligned with the center opening 100 formed in the rear wall 52 of the first cross beam 16 so that air directed through the center fluid duct 290 fluidly passes through the center opening 100 and away from the rear surface 52 of the first cross beam 16. In addition, the third fluid duct 310, comprising the integral defroster, is aligned with the elongated opening 30 so that air may fluidly communicate therebetween to provide the desired defrosting action. Openings 33 are disposed above the second fluid duct 300 so that fluid flows away from the second fluid duct 300 and exits therefrom at these predetermined locations.

According to the present invention, the assembly of the first section 12 and the second section 14 completes and seals the first, second, and third air ducts 220, 300, 310, respectively, except for the selectively formed openings located in the first section 12. More specifically, the upper wall 18 of the first cross beam 16 serves to enclose the upper open portions of the first, second, and third air ducts 220, 300, 310 because the upper wall 18 extends across the upper edges of the rear surface 208, inner wall 222, and front surface 302. Accordingly when the first section 12 and the second section 14 are coupled together to form ISHS 10, the raised rear surface 272 of the second cross beam 200 seats against the complementary and similarly shaped raised portion 120 of the first cross beam 16 while the HVAC module upper casework 270 is not restricted so that air may flow therethrough via inlet portion 277 and

into at least one of the first, second, and third air ducts 220, 300, and 310. As is known in the art, a controller including a valve device or the like (not shown) may be used for selectively directing the fluid flow within the ISHS 10. More specifically and depending upon the mode which the occupant of the vehicle has selected, the fluid entering the HVAC module upper casework 270 by way of the inlet portion 277 may be routed in one of the given fluid ducts 220, 300, 310 integrally formed in the ISHS 10 by either permitting or restricting the fluid from flowing within these fluid ducts.

Figure 8 is a cross-sectional side elevational view of the ISHS 10 in an assembled condition. In one exemplary embodiment, the first section 12 includes raised integral features 313 which extend upwardly from the upper wall 18. The raised integral features 313 are formed about the second fluid duct 300. In one exemplary embodiment, the raised integral features 313 serve as integral instrument panel attachment features. As shown in Figure 8, the first section 12 and the second section 14 are complementary to one another and mate with one another in an interlocking manner so that the openings and the fluid ducts align with each other.

The ISHS 10 is formed of any suitable material which is capable of being molded and in an exemplary embodiment, the ISHS 10 is formed of a plastic material. Any suitable process may be used to securely couple the first section 12 to the second section 14 to form the ISHS 10. In one exemplary embodiment, a welding process is used. For example, a vibration welding process may be used to securely attach the first and second sections 12, 14, respectively, to form the ISHS 10.

According to the present invention, the ISHS overcomes the deficiencies and limitations of the prior art by providing an integrated structure having a high degree of functional and physical integration which offers the following benefits. The ISHS is formed of a plurality of molded members. For the purpose of illustration only, the ISHS has been described with reference to two molded members, namely the first and second sections; however, one will

appreciate that three or more molded members may be used to form the ISHS according to the teachings of the present invention. First, the present invention provides product packaging improvements due to the HVAC module integration into the cross-car beam. This integration enables the HVAC module, primarily the valving, to be packaged in a higher vehicle position enabling a more spacious interior compartment. This can lead to a volume savings potential on the order of about 2-6 liters. Second, due to the high degree of integration, the cost of the ISHS compared to conventional multi-component devices shows a competitive benefit. Third, the mass of the ISHS shows an improvement versus prior art because of the high level of part integration. Fourth, tooling cost is improved compared to conventional prior art due to the maximized feature integration of the ISHS. The ISHS of the present invention also provides the ability to tune structural performance by strategic material selection and part design. The high level of integration demonstrated in the ISHS provides for a more robust system design because the integral nature of the ISHS eliminates the need to attach parts to the main structure. Fewer attached parts translates to less opportunity for squeak and rattle and other quality deficiencies.

Referring now to Figures 9-10 in which a second embodiment of a first section is shown and is generally indicated at 400. The first section 400 is similar to the first section 12 of the first embodiment and for ease of illustration and description of the present invention, a detailed description of first section 400 will be omitted. The first section 400 includes rear surface 52 and a pair of first knee energy absorbers 402 and a pair of second knee energy absorbers 404. The pair of second knee energy absorbers 404 are disposed intermediate to the first knee energy absorbers 402., The first knee energy absorber 402 includes a rear vertical section 406 which is integral to the rear surface 52 and a first surface 408 and a second surface 410 which integrally converge with each other at a section 412. In this embodiment, the slope of the first surface 408 and the second surface 410 are similar to one another.

The first knee energy absorber 402 also includes an integrated trim attachment 414 (best shown in Figure 10). The integrated trim attachment 414 comprises a tab extending downwardly from the second surface 410. In the illustrated embodiment, the integrated trim attachment 414 is generally rectangular in shape and has an opening 416 formed therethrough. The opening 416 is designed to receive a fastener (not shown) or the like to attach any number of trim components to the first section 400. The second knee energy absorbers 404 also include the integrated trim attachment 414 which extends therefrom.

Referring now to Figure 11 in which a third embodiment of a first section is shown and is generally indicated at 500. The first section 500 comprises a structural cross beam 502 which includes a rear surface 503 which is designed to face the occupants of the vehicle. In the illustrated embodiment, the first section 500 generally has a first end portion 504, a second end portion 506, and a center portion 508 disposed therebetween. Between a portion of the first end portion 504 and the center portion 508 a first slot 510 is formed and between a portion of the second end portion 506 and the center portion 508, a second slot 512 is formed. The first and second end portions 504, 506, respectively, each include a first knee energy absorber 514 extending outwardly from the rear surface 503. According to the present invention, the first knee energy absorber 514 comprises a first surface 520 which extends downwardly from the rear surface 503 and a second surface 522 which extends upwardly from the rear surface 503. The first knee energy absorber 514 includes a planar center section 524 which extends between the first and second surfaces 520, 522. The planar center section 524 comprises the rearward most portion (closest to the occupants of the vehicle) of the first knee energy absorber 514. The planar center section 524 may include openings 526 formed therein to permit attachment of components (not shown) to the first knee energy absorber 514.

The first energy absorber 514 includes a vertical section 528 which extends downwardly from one edge 530 of the structural cross beam 502. One end of each of the first and second surfaces 520, 522 is integral to the vertical section 528. In the illustrated embodiment, the vertical section 528 is formed on one side of the first and second surfaces 520, 522 and the first end portion 504 forms the other side of the first and second surfaces 520, 522. The first and second surfaces 520, 522 are angled away from the rear surface 503 and towards one another at one end thereof so as to converge at the planar center section 524. An opening 540 is formed between the first and second surfaces 520, 522. In addition, in the illustrated embodiment, the rear surface 503 is substantially open behind the first knee energy absorber 514. The first knee energy absorber 514 also includes an integral trim attachment 542 which extends downwardly from the second surface 522. The integral trim attachment 542 has an opening 544 formed therein to aid in the attachment of various components to the first knee energy absorber 514.

According to the present invention, a structural beam, e.g., a structural cross beam for use in a vehicle, is provided with integral features and more specifically, the present invention teaches a structural cross beam with integral knee energy absorbers. The present invention overcomes the deficiencies of the prior art by providing a more robust system design. The integration of the knee energy absorbers into the structural cross beam provides for a readily recyclable sub-system. This results because no disassembly nor separation of materials is required. Because of the increased mass of the structural beam with integrated knee energy absorbers, the present invention provides a structure having solid construction. This results because conventional beams include separate components fastened to one another, e.g., separate steel brackets fastened to the beam).

In addition, the present invention provides cost benefits in comparison to the conventional assemblies of the prior art. Due to the integration of the knee energy absorbing brackets, the price of the sub-assembly

compared to the devices of the prior art shows a competitive benefit. The tooling cost is improved in comparison to conventional devices because the present invention does not require separate tooling and operations to fabricate and assemble the knee energy absorbers to the structural beam as is required in conventional assemblies having separate brackets which are fastened to the structural beam.

Furthermore, the present invention provides the ability to tune occupant energy performance by strategic material selection and part design. For example, the material used to form the structural beam including the knee energy absorbers may be carefully selected to provide desired occupant energy performance. The integrated knee energy absorbers also provide attachment locations for various trim components and for an instrument panel cover. Accordingly, the integration demonstrated in the present invention provides for a more robust system design because the design has fewer attached parts which translates to reduced opportunity for squeaks and rattles and other quality deficiencies to occur.

It will be appreciated that the structural beams illustrated herein are merely illustrative of exemplary structural beams having integral knee energy absorbers. However, the scope of the present invention is intended to cover any structural beam having an integrated knee energy absorber structure. Thus, there are numerous designs that the structural beam may have according to the present invention so long as the knee energy absorbers are integrally formed therewith.

It will be understood that a person skilled in the art may make modifications to the preferred embodiments shown herein within the scope and intent of the claims. While the present invention has been described as carried out in a specific embodiment thereof, it is not intended to be limited thereby but is intended to cover the invention broadly within the scope and spirit of the claims.

CLAIMS

What is claimed is:

1. An instrument panel structure for use in a vehicle, the instrument panel structure comprising:

a first cross beam; and

a plurality of knee energy absorbers integrally formed with the first cross beam.

2. The instrument panel structure of claim 1, wherein the plurality of knee energy absorbers comprise a pair of first knee energy absorbers formed at ends of the first cross beam and a pair of intermediate knee energy absorbers formed therebetween.

3. The instrument panel structure of claim 1, wherein each of the plurality of knee energy absorbers includes first and second surfaces which are integral to a first surface of the first cross beam and extend thereaway and converge with one another.

4. The instrument panel structure of claim 3, wherein the first and second surfaces are angled relative to the first surface of the first cross beam.

5. The instrument panel structure of claim 1, wherein each knee energy absorber includes a planar surface formed between the first and second surfaces.

6. The instrument panel structure of claim 5, wherein each planar surface includes an opening for attachment of a member thereto.

7. The instrument panel structure of claim 1, wherein each of the plurality of knee energy absorbers is generally "D" shaped.

8. The instrument panel structure of claim 1, where each of the plurality of knee energy absorbers includes an attachment tab integrally formed therewith.

9. The instrument panel structure of claim 7, wherein the attachment tab extends downwardly away from the knee energy absorber. the attachment tab providing an attachment surface for a member to be attached to the first cross beam.

10. The instrument panel structure of claim 9, wherein the member comprises a trim component.

11. The instrument panel structure of claim 1, wherein each knee energy absorber includes a rear surface which is an integral part of the first cross beam, each of the plurality of knee energy absorbers including first and second surfaces which are integral at one end with the rear surface.

12. The instrument panel structure of claim 1, wherein the plurality of knee energy absorbers are formed of a material selected to provide preselected occupant energy performance.

13. The instrument panel structure of claim 3, wherein each knee energy absorber includes an opening formed between the first and second surfaces.

14. The instrument panel structure of claim 3, wherein the first cross beam includes an upper surface which is generally perpendicular to the first surface; and wherein the instrument panel structure further includes:

a second cross beam having a plurality of fluid ducts formed therein, the first and second cross beams mating with one another so that the upper surface of the first cross beam extends across the second cross beam to partially enclose the plurality of fluid ducts.

15. A structural beam for use in a compartment, the structural beam comprising:

a cross beam; and

a plurality of knee energy absorbers integrally formed with the cross beam.

16. The structural beam of claim 15, wherein each knee energy absorber includes first and second surfaces which extend away from the cross beam and are integral with each other and with the cross beam.

17. The structural beam of claim 15, wherein each of the plurality of knee energy absorbers includes an integral attachment tab extending therefrom.

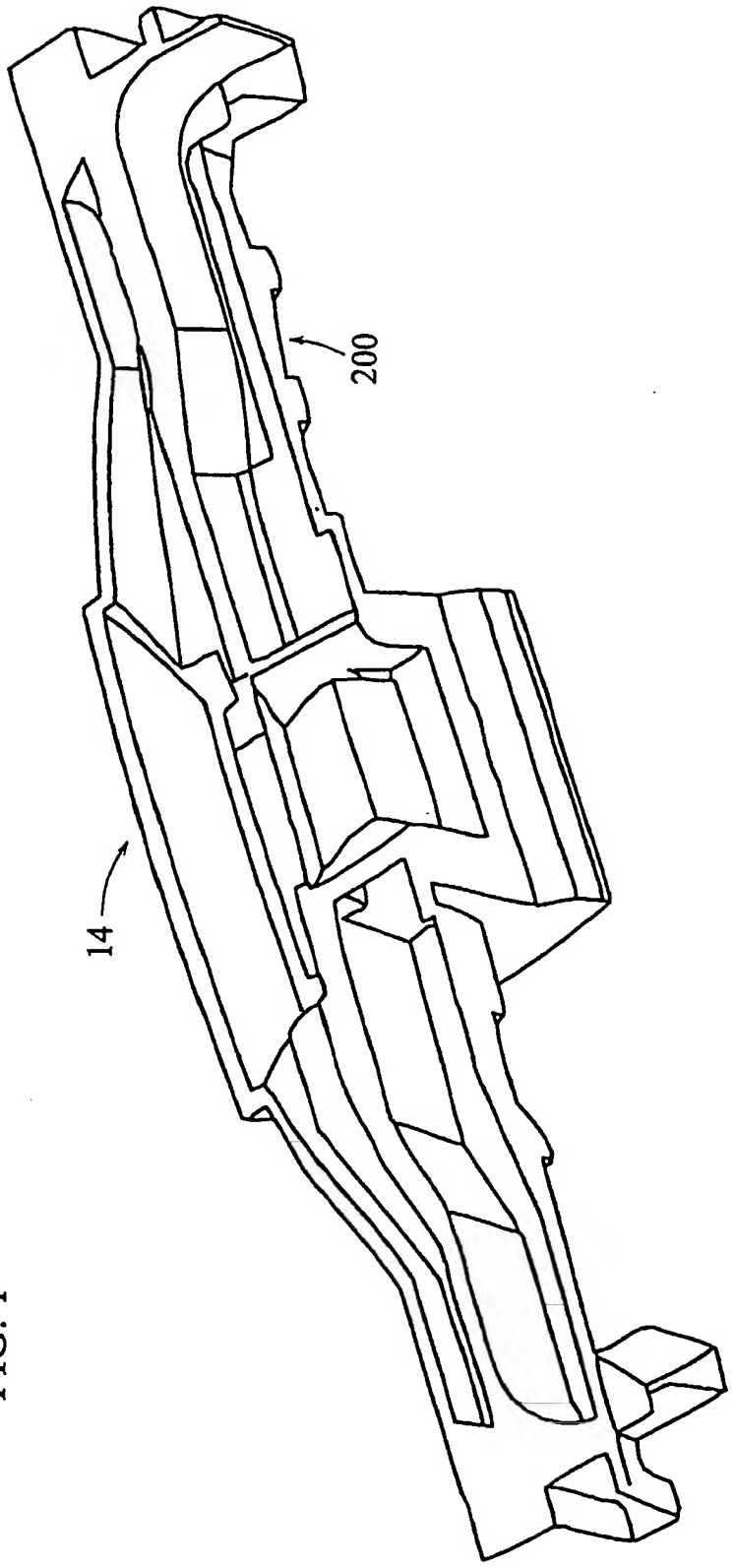

FIG. 1

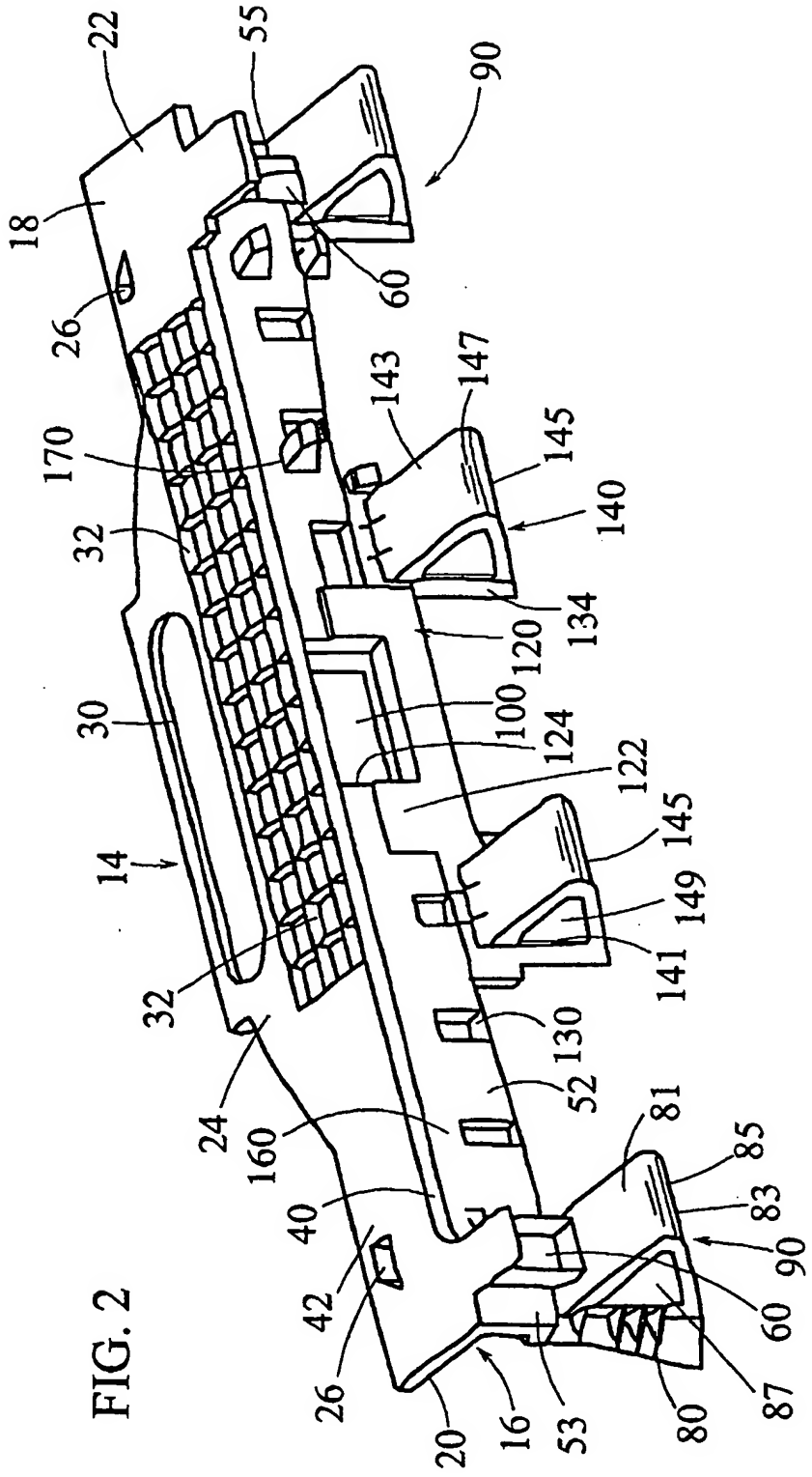
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FIG. 2

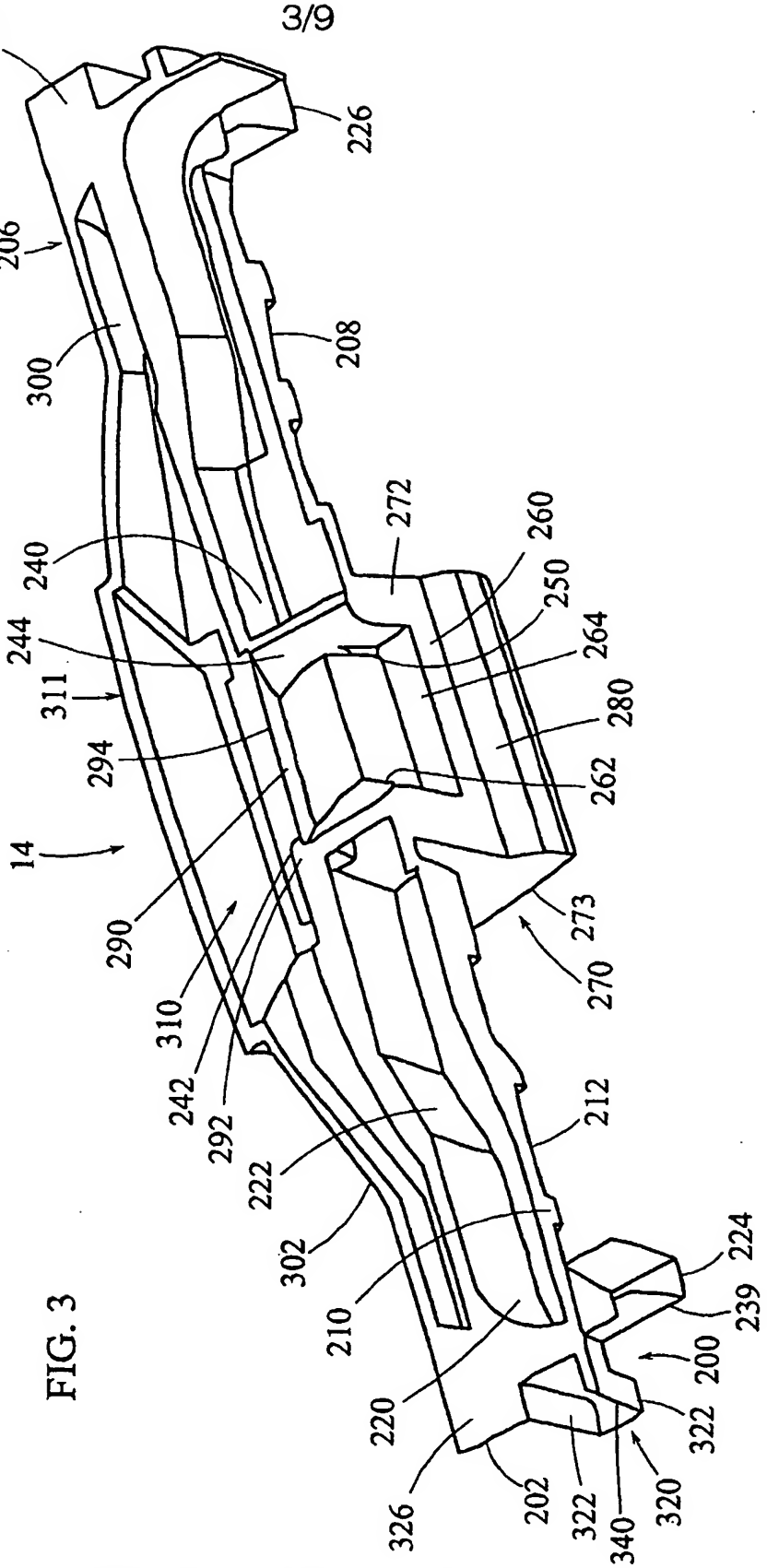
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FIG. 3

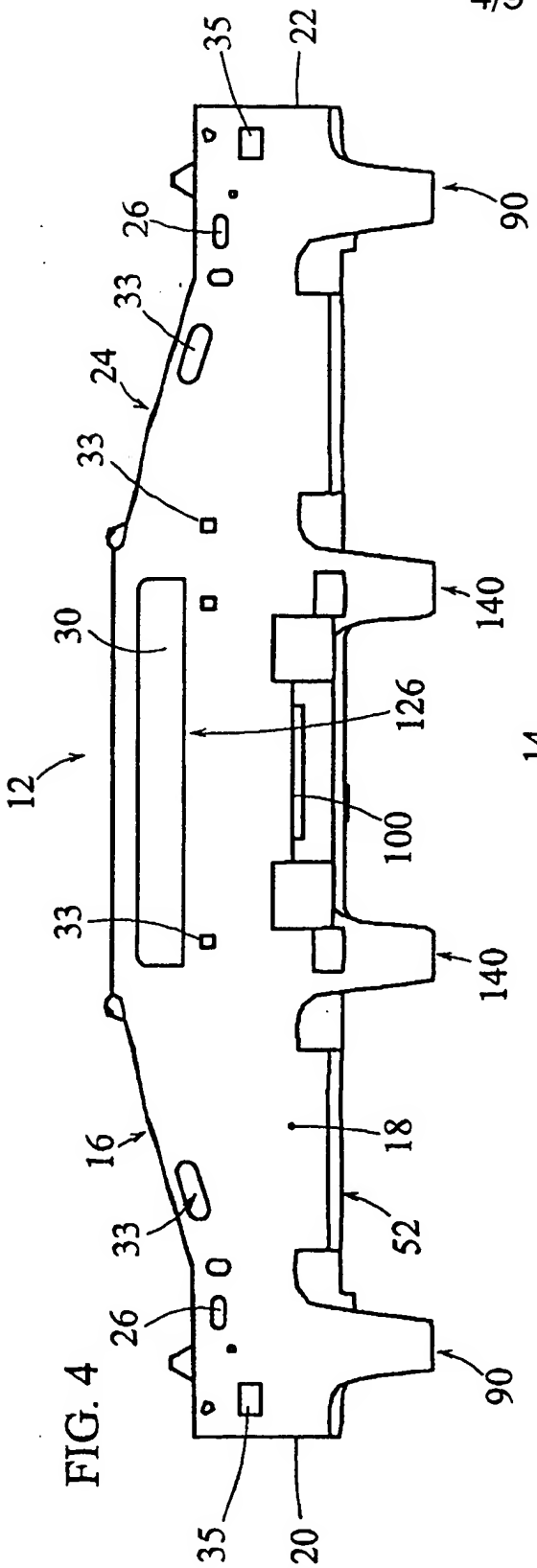
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FIG. 4

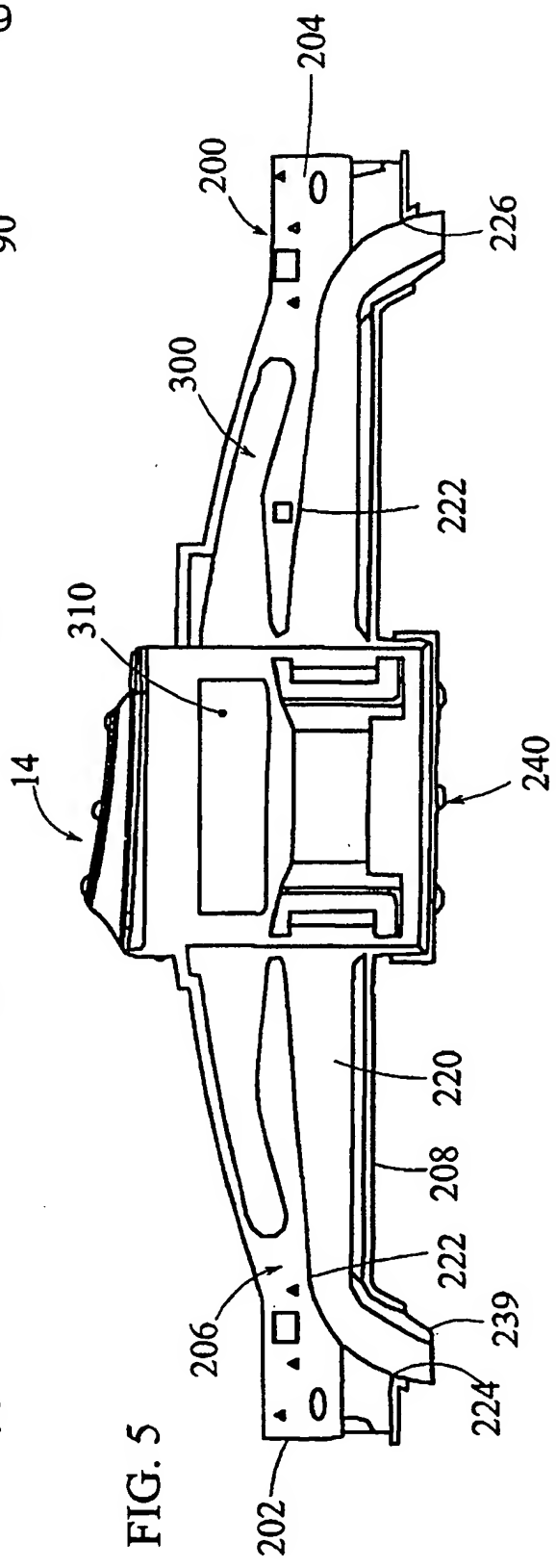
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FIG. 5

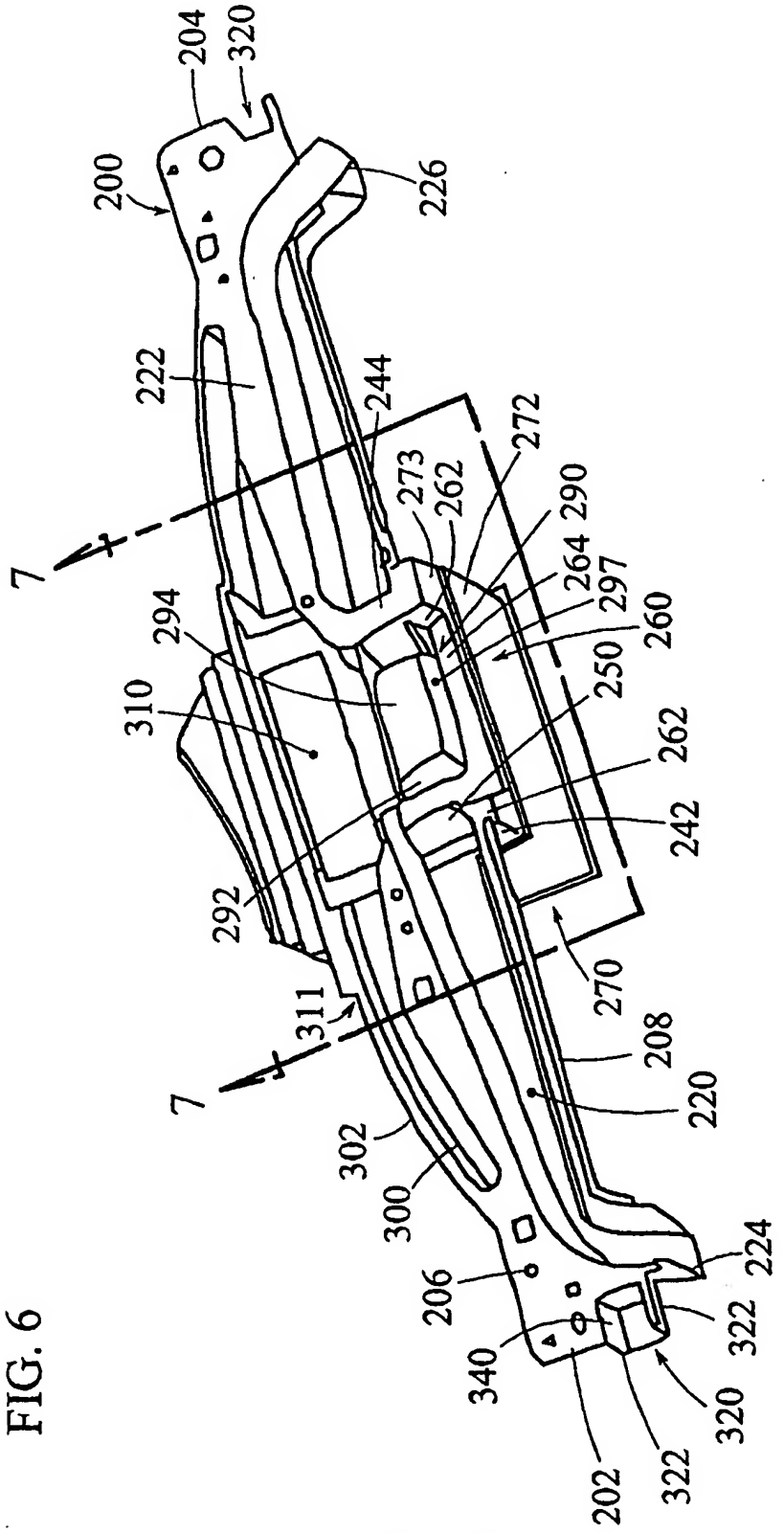
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FIG. 6

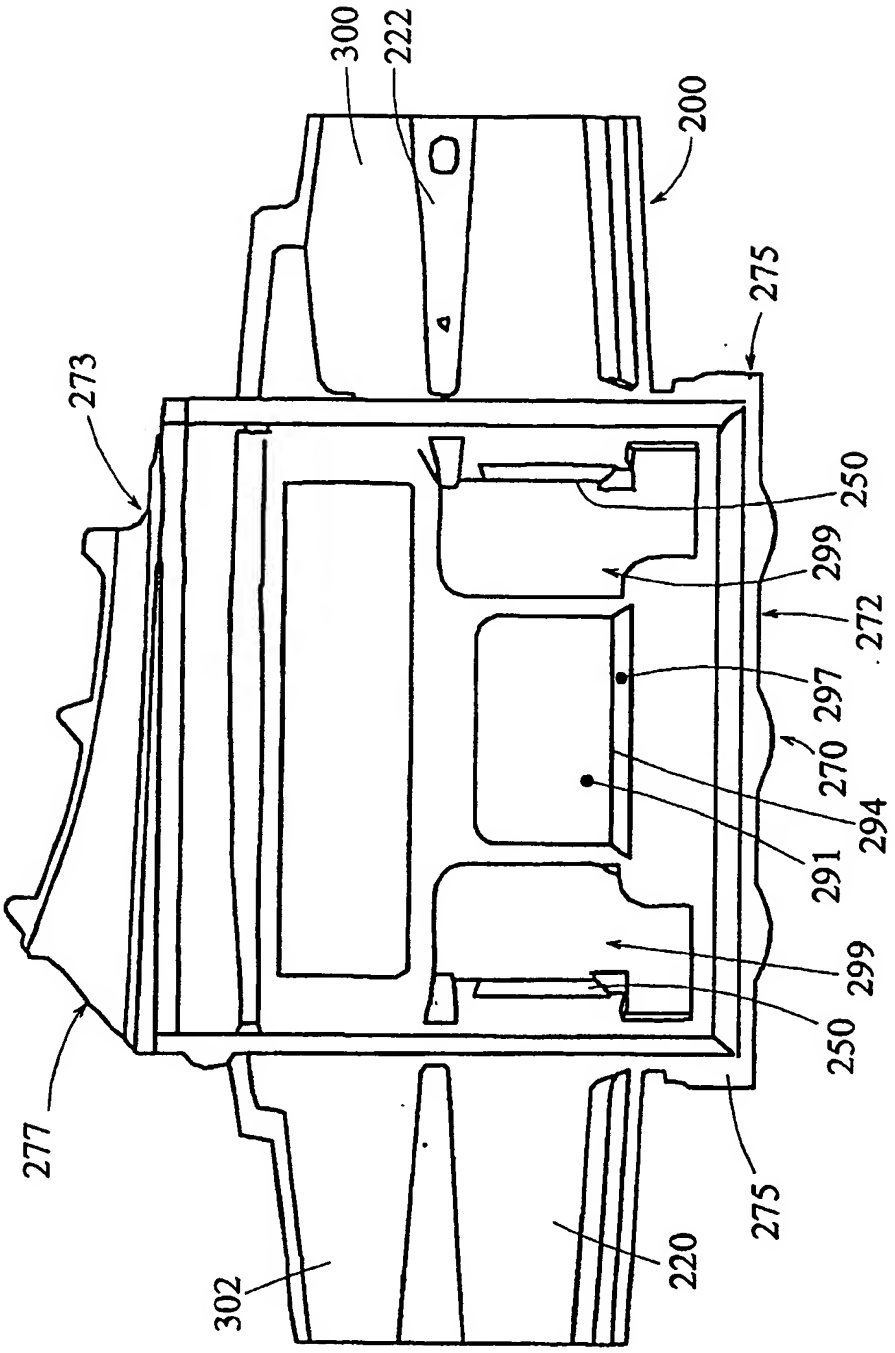
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FIG. 7

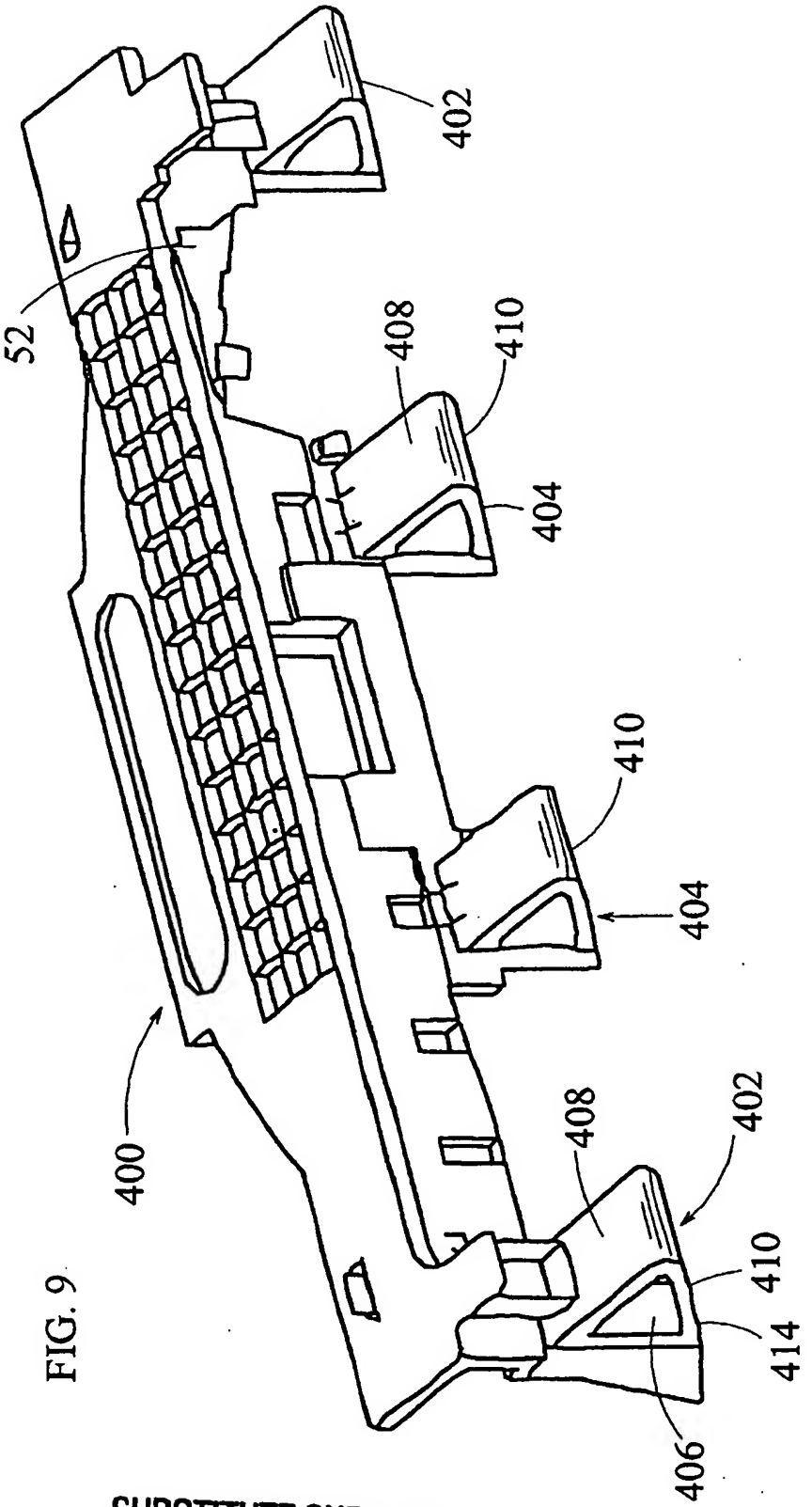


FIG. 9

FIG. 8

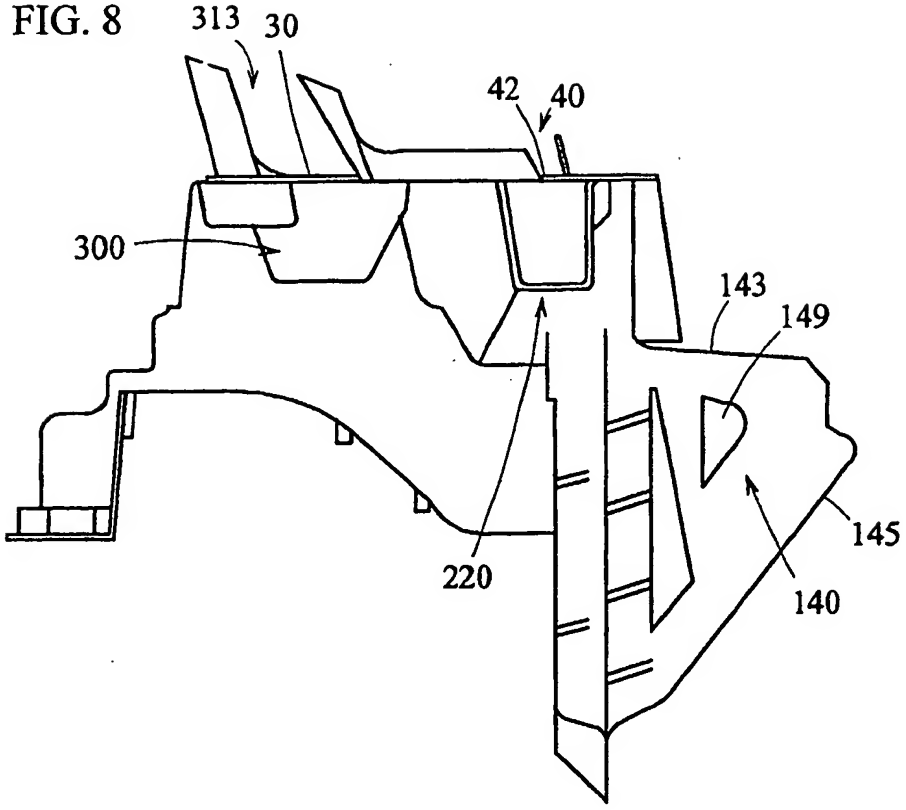
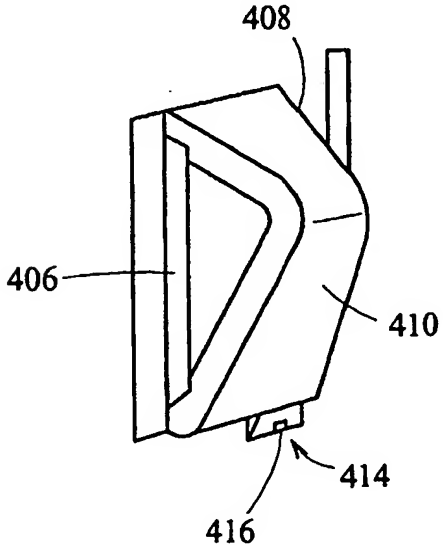


FIG. 10



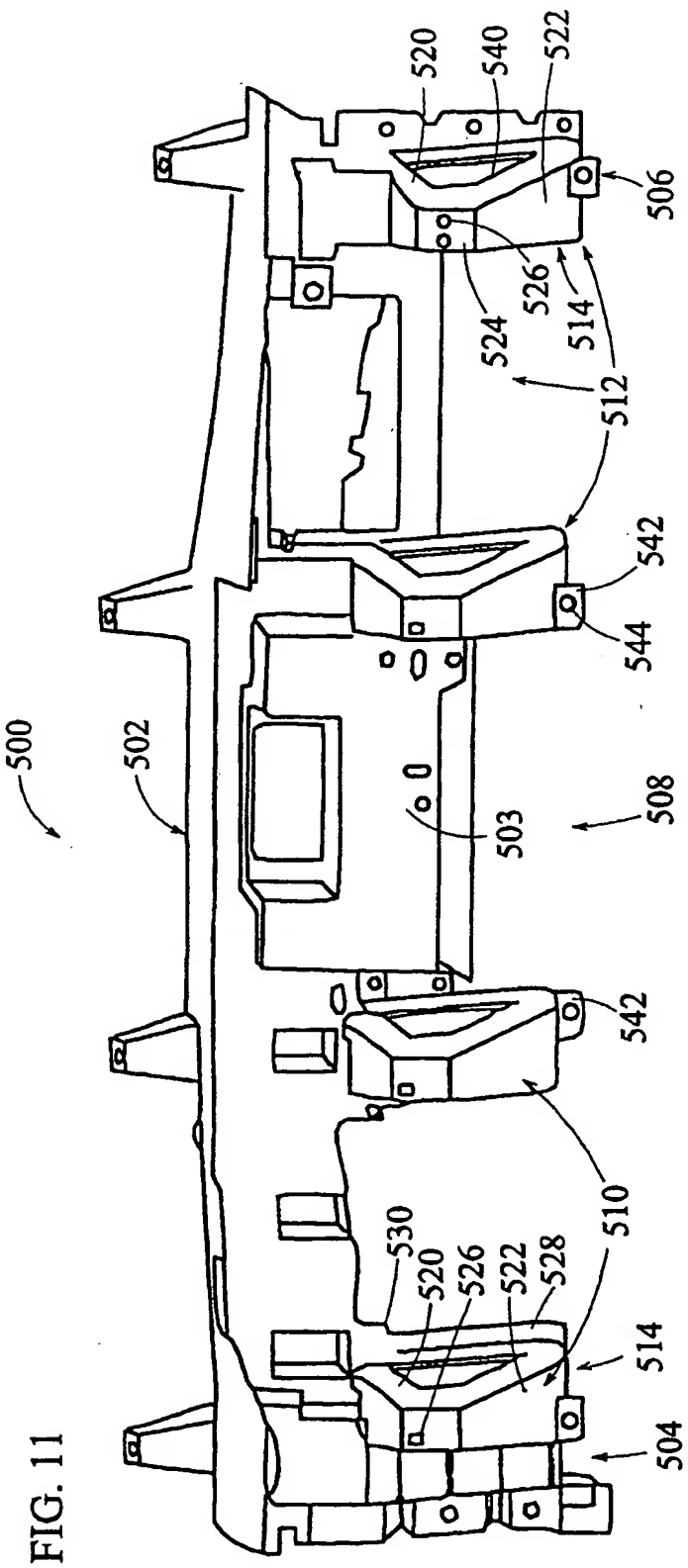

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FIG. 11

INTERNATIONAL SEARCH REPORT

In: tional Application No
PCT/US 01/40389

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60R21/045 B62D25/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60R B62D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 326 130 A (GEDEON DALE G ET AL) 5 July 1994 (1994-07-05) abstract column 2, line 11 - line 42 column 2, line 63 -column 3, line 13 figures ---	1,3, 11-13, 15,16
P,X	WO 00 50292 A (LEAR CORP) 31 August 2000 (2000-08-31) abstract page 4, line 7 - line 20 page 6, line 24 -page 7, line 10 figures 1,2,7	1,5,15
A	---	14
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 July 2001	06/08/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	PELTZ, P

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

In' tional Application No
PCT/US 01/40389

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 960 785 A (FUJI HEAVY IND LTD) 1 December 1999 (1999-12-01) abstract column 2, line 28 - line 49 figure 1	1-7,12, 13,15,16
P,A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 07, 29 September 2000 (2000-09-29) & JP 2000 103307 A (DAIHATSU MOTOR CO LTD), 11 April 2000 (2000-04-11) abstract	1,8,15, 17

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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/40389

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5326130 A	05-07-1994	NONE	
WO 0050292 A	31-08-2000	NONE	
EP 0960785 A	01-12-1999	JP 11321501 A	24-11-1999
JP 2000103307 A	11-04-2000	NONE	